No. 7

Dam Safety Outlet

DAM SAFETY PROGRAM

March 2004

Montana Department of Natural Resources and Conservation

Outlet Pipe Replacement - Where Do I Go From Here?

One of the most disheartening statements a dam owner can hear is that the outlet pipe needs to be replaced. The dam owner, with good reason, is seeing huge dollar signs flash before his or her eyes. But similar to any large capital expenditure, it is best to know the options available so the best choice can be made to save money now and have a useable outlet far into the future.

Upper Taylor Dam Outlet - Photo by Terry Voeller, DNRC

Outlet replacement always requires that a filter be placed around the outlet. This filter is the same in principle as a coffee filter. It will allow water to run along the pipe, but will not allow dam material to exit.

There are really only two alternatives available for outlet replacement. Obviously, the first is digging up the current outlet and replacing it. The second is slip lining the existing pipe with an internal pipe. The internal pipe used is often extremely thick-walled plastic and called high-density polyethylene (HDPE). Since the internal HDPE pipe is smooth, the water conveyance capacity remains close to the same, when compared with the larger, corrugated metal pipe (CMP).

The most common problem with slip lining is properly grouting the space between the two pipes. In theory, the entire space should be grouted. In reality, this is often hard to achieve. Often, the pipe is grouted a distance downstream of the gate and a distance upstream of the exit, and the interior is left ungrouted. Sometimes only the upstream portion of the pipe is grouted, and the downstream portion is allowed to drain.

The pipe upstream of the gate is seldom slip lined because this

(Continued on Page 3)

Development of Ground-Shaking Maps Nearing Completion

Earthquakes have been known to cause great damage to dams. Since Montana is a very seismically active state, dams must be designed so that ground shaking does not cause excessive damage. However, predicting the loation and the intensity of the ground shaking is difficult in Montana. In 2002, Montana Department of Natural Resources and Conservation (DNRC) hired URS Corporation out of Oakland, California, to develop detailed ground-shaking maps for Montana, to assist with this prediction.

The map development is near completion. Currently, a technical oversight committee is reviewing drafts of the maps. Final maps should be ready in the spring. The maps will encompass the entire state and will be available both in hard copy and electronically, in a Geographical Information System (GIS) format.

What's next?

DNRC plans to host a one-day workshop in May 2004 on the development and application of the ground-shaking maps. In the morning, URS Corporation will discuss the development of the maps, where they can be applied, and the assumptions involved, as well as the limitations. They will also discuss the detailed fault maps that were produced. In the afternoon, there will be a hands-on workshop on the use of the maps to analyze existing dams for both liquefaction potential and deformation if subjected to ground shaking. The State will also present a proposed seismic design standard for public comment. The workshop will be free of charge.

The Montana Bureau of Mines and Geology (MBMG) will be publishing a formal report on the development of the ground-shaking maps. The maps will also be downloadable from the MGMG website.

If you are on our mailing list, you will be receiving notification of the workshop. For more information, or to be added to our mailing list, please contact Michele Lemieux at (406) 444-6613 or mlemieux@state.mt.us.

Dam Files Being Imaged for Computers

The Dam Safety Program is currently imaging its files for dams that receive operation permits. Some of the information in these files includes operation and maintenance manuals, correspondence with the dam owner and the dam owner's engineer, photographs, engineer inspection reports, design reports, drawings, and computations. The emergency action plans are not included since they are updated every year. Once all the files are imaged, they will be updated only every five years.

Why are we imaging these files?

We often get requests for information from engineers when dam owners are hiring an engineer for inspection or have issued a request for proposals for a construction project. Our files often have hundreds of pages. Not only does the sheer volume prevent us from photocopying them, but also many of the pages are larger than standard size and include photographs. Therefore, in the past, we have mailed our one and only copy to engineers and nervously hoped it didn't get lost in the mail.

Imaging also preserves the files in case of a fire or other disaster.

Finally, many of the drawings and other documents associated with the construction of dams predate 1940. Many of these documents are aging, and imaging allows them to be copied, preserved, and distributed.

If you have any original drawings, photographs, or records for your

(Continued on Page 4)

(Outlet Pipe Replacement - Where Do I Go From Here...Continued from Page 1)

portion of the pipe is constantly filled with water. Therefore, it is not prone to corrosion. If the outlet gate is located on the upstream face of the dam, the reservoir would have to be drained in order to slip line. This defeats the purpose for which slip lining is often done, which is to avoid having to drain the reservoir for construction.

So why would a dam owner decide on pipe replacement over slip lining? There are several reasons. The dam height might be so low that replacing the pipe would be cheaper than dealing with the construction costs of slip lining. The original pipe might be so small in diameter that slip lining is impractical. Insertion into the original pipe may be impossible. Finally, the original pipe might be in such bad shape that significant dam material has been removed through the holes in the pipe. Once this situation has occurred, pipe replacement is really the only option left.

If a dam owner decides to replace the outlet, there are two common choices of pipe material, and they are (1) concrete, or (2) HDPE pipe. Although other pipes are available, they are used infrequently. Therefore, they are not discussed in this article.

Several factors need to be taken into consideration when making the choice between concrete or HDPE. Properly bedding the pipes is important no matter which choice is made. One of the big differences between the two pipe materials is the load that they can handle. HDPE pipe appears to work well for dams of less than 20 feet in height. If a dam's height exceeds 20 feet, much more care is needed in engineering design of HDPE pipe. Concrete pipes, if designed and bedded properly, can handle dam heights well in excess of 20 feet.

There are several advantages to HDPE pipe. The pipe is light and easy to handle, which saves labor and equipment. The pipe is strong, durable, corrosion resistant and watertight. Heat-fused joints can easily accommodate pressurized situations, allowing the use of a downstream gate.

The major concern with HDPE pipe is the lack of a long-term performance record. HDPE pipes have been used in dams for only about 20 years. There remain widely differing opinions when it comes to the use of bedding and cradles for the pipe. The opinions vary from completely encasing the pipe in concrete to using soils that, when properly compacted, are somewhat flexible. The current thinking is that using nonflexible bedding such as concrete with a flexible pipe is incompatible. Again, there are no long-term data to verify this conclusion.

HDPE pipe does have other undesirable properties. These include combustibility, deformability over time, degradability over time with exposure to sun, and a high ability to expand and contract with temperature. The significance of these properties will only be known in time.

So what should a dam owner do? In the case of outlet replacement, the old adage, "Don't be penny-wise and pound-foolish," comes into play. In most cases, engineering costs will be significantly lower than construction costs. Therefore, it will be to your advantage to have your engineer come up with several alternatives so you can make a more educated decision. This could actually save you money in the long run. For example, if the cost of outlet replacement with concrete pipe ends up being just slightly higher, you may decide it is worth the little extra money to go with the "tried and proven."

Remember, this article is limited in scope with regard to all the options that are available. Therefore, it never hurts to find out the experience that your engineer and contractor have, not only in outlet replacements, but also in design and construction of filters. There are always new pipe materials, methods of slip lining, and filter materials with which experienced engineers and contractors will be familiar.

Published guidelines will soon be available for engineers. Through the National Dam Safety Program, the U.S. Bureau of Reclamation with cooperation from several other agencies is developing guidelines for design, problem identification, and repair of pipes through dams. The planned distribution date is summer 2004.

Development Downstream of My Dam Frequently Asked Questions

Why should I care about development downstream of my dam?
Increased development below your dam increases your liability. This increased liability could decrease your property values. Also, when more people live below a dam, they usually make more demands on dam operations. Finally, development can lead to more stringent dam safety requirements being placed on your dam.

I thought a high hazard dam is a high hazard dam. What difference does development make on my dam safety requirements?
The trend in dam safety regulations is toward risk-based standards. This means that, as development of the area downstream of your dam increases, the amount of risk your dam poses increases, and the safer your dam will have to be. In Montana, we already have a risk-based spillway standard and are moving toward a risk-based seismic evaluation.

Can I prevent development downstream of my dam?
If you try to prevent development based solely on the assumption that your liability would increase, the answer would most likely be no. This type of decision can be made only at the county level through some sort of zoning or land use planning process.

Is that fair?
To the dam owner, it doesn't seem fair. But, if development were prevented downstream of dams, would that be fair to the downstream property owners? After all, high hazard dams for which operation permits have been obtained should have at most a 1-in-500 chance of failure each year. Most dams have an even smaller chance of failure. Should we prevent development when there is such a small chance of failure?

If my dam has such a small chance of failure, then why should I be under any more stringent standard when development increases?
As a society, we are much more willing to accept natural disasters than we are disasters resulting from man-made circumstances. Like it or not, we do not accept airline crashes, building collapses, or dam failures nearly as well as we do floods, hurricanes, and earthquakes.

So what can I do?
If your dam is not used for flood control, you should encourage your county to enforce floodplain regulations below your dam. You should strongly encourage county officials to have the floodplain of the stream that your dam is on mapped. If your county is not in the Federal Emergency Management Agency (FEMA)

(Continued on Page 6)

(Dam Files Being Imaged for Computers...Continued from Page2)

dam, we would appreciate it greatly if you would let us borrow them for imaging. We are able to handle documents of any size, including large drawings.

The images are in JPEG format. This is the common format used with most digital cameras. They can be read using Windows or common photo software such as PhotoShop or Photo Editor, but are best read using software called ACDSee. ACDSee can be downloaded off the Internet for around $50. The site is at http://www.acdsystems.com/English/index.htm.

Most files for dams have been placed on one CD. Some of the larger files have required two CDs. It will now be much easier to distribute information about your dam to those asking for it. Due to the fact that these files are public information, this information will be distributed to anyone asking for it, including people that may be concerned about your dam.

Currently, the files for 23 dams have been imaged. Dam owners obtain operation permits for over 70 dams. We hope to have all files imaged in another three years. We are always ready to change priorities regarding the order in which the dams are being done. Therefore, do not hesitate to e-mail Terry Voeller at tvoeller@state.mt.us or call him at 444-6664 if you have a need to have the file for your dam imaged.

THE Dam News
FROM AROUND THE STATE

RENEWABLE RESOURCES GRANT AND LOAN PROGRAM

The deadline for submitting your grant application for the Renewable Resource Grant and Loan Program is May 15, 2004. The application booklet and information about the program, ranking criteria, etc., can be found on DNRC's website (http://www.dnrc.state.mt.us/) under "Loans and Grants." You can also call 444-6687 for information.

GROUND-SHAKING MAP DEVELOPMENT AND SEISMIC ANALYSIS TECHNIQUES WORKSHOP

This workshop will be presented in conjunction with the 39th Symposium on Engineering Geology and Geotechnical Engineering, sponsored by Montana Tech, which will be held in Butte, Montana, May 18-21, 2004. The workshop will be on May 20.

NEVADA CREEK DAM

Nevada Creek Dam is a state-owned dam located in Powell County about 20 miles northwest of Avon adjacent to Highway 141. The dam is 88 feet high with a storage of 11,152 acre-feet. The construction work to rehabilitate the dam began in 2002 and was completed in 2003.

The first phase of the work consisted of a seepage collection system, dewatering wells, a toe berm, extending the low-level outlet conduit, and processing material for the second phase. Smith Contracting of Butte was the contractor for the first phase of the work.

The second phase consisted of constructing a new primary spillway, adding fill to the dam crest to bring it up to design elevation, lowering part of the dike section, adding a flow restriction wall in the original spillway, and placing the excavated material from the primary spillway into the original spillway so that it can be used as an emergency spillway. This material in the original spillway will act like a fuse plug. Johnson-Wilson of Helena constructed the second phase.

HKM Engineering of Billings provided the design and construction management for both phases of the project.

The total cost of the project is about $3 million. The Nevada Creek Water Users Association will pay approximately $500,000. The remaining funds are provided from various state sources including earnings from the Broadwater Hydropower Project, the DNRC Water Storage Account, and a Renewable Resource Grant from the Coal Severance Tax Trust Fund.

NORTH FORK OF THE SMITH RIVER DAM

The North Fork of the Smith River Dam is a state-owned dam located in Meagher County about 10 miles northeast of White Sulphur Springs adjacent to Highway 12. The dam is 84 feet high and has a storage of 11,406 acre-feet. The DNRC State Water Projects Bureau is in the process of

(Continued on Page 6)

(Development Downstream of My Dam...Continued from Page 4)

Floodplain Program, you should encourage its participation. Enforcement of county floodplain regulations will help regulate and/or prevent development within the boundaries of the 100-year floodplain below your dam. This designation will not only help you, but also help future homeowners.

Dam failure floods are much higher than the 100-year flood; what good does this do me?

Regardless of the dam's size, the floodway portion within the 100-year floodplain below a dam is the area where the most devastation from dam failure would occur. For smaller dams, the dam breach flood area may be only slightly larger than the 100-year floodplain. Even for larger dams, the area difference will get smaller as you move a significant distance below the dam. Placing the 100-year floodway out of development could significantly reduce the estimated loss of life below your dam. This would result in less stringent standards being placed on your dam.

(The Dam News...Continued from Page 5)

selecting an engineering consultant for design and construction management services for a new spillway, outlet, and seepage improvements. The design is anticipated to be completed in 2004 with construction in the late summer and early fall of 2005.

The complete project is estimated to cost about $825,000. The North Fork of the Smith Water Users Association will pay approximately $425,000. The remaining funds are provided from various state sources including earnings from the Broadwater Hydropower Project, the DNRC Water Storage Account, and a Renewable Resource Grant from the Coal Severance Tax Trust Fund.

Inside this Issue.....

Outlet Pipe Replacement - Where Do I Go From Here? .....Page 1
Development of Ground-Shaking Maps Nearing Completion.....Page 2
Dam Files Being Imaged for Computers.....Page 2
Development Downstream of My Dam - Frequently Asked Questions.....Page 4
The Dam News From Around The State.....Page 5

Persons with disabilities who need an alternative, accessible format of this document should contact: DNRC, 1424 9th Avenue, P.O. Box 201601, Helena MT 59620-1601, Phone (406)444-6601/ Fax (406)444-0533/TDD: (406) 444-6873
400 copies of this document were published at a total cost of $191 which includes $64 for printing and $127 for distribution.

DAM SAFETY PROGRAM
DNRC—WATER RESOURCES DIVISION
P.O. BOX 201601
HELENA, MT 59620-1601